say that it is nearly as great as in the whole order of the Scrophularineæ. The two principal kinds of variation are the length and the relative diameter of the tubular portion, and the shape of the lips, especially of the upper one, of which there are many curious and even fantastic modifications. Maximowicz's monograph of the whole genus (which is dispersed all round the northern hemisphere, and perhaps extends just over the equator in the Andes) includes about 250 species, and a few have been discovered in India and China since. Prain's monograph of the Indian species contains nearly double the number described in the "Flora of British India" in 1884. The systematic part is preceded by an elaborate and masterly essay on the distribution and descent of the species, illustrated by diagrams and a map. The latter might certainly, with a little extra work, have been made clearer. Dr. Prain divides the genus primarily into three groups—namely, *Longirostres*, *Aduncæ*, and *Erostres*—based on the modifications of the upper lip of the corolla; and the names are sufficiently descriptive to indicate their application. Each of these groups contains both opposite (or verticillate) and alternate leaved species, and is subdivided into a number of sections. So far as we have tried the keys to the sections and species we have found them work admirably, and the descriptions are evidently very carefully written; but twelve to eighteen lines of description in the ablative absolute without a stop or any variation in type is bewildering, and an innovation that is to be deprecated. Dr. Prain himself appears to have realized this, for in his account of *Gomphostemma* his descriptions are shorter and punctuated, with the names of the various organs in italics.

Dr. King's monographs of the Magnoliaceæ and the genus *Myristica* are written entirely in English, perhaps with advantage, because Latin descriptions are not so easily understood as English by many persons interested in trees. Including the suborder Schizandreæ, the number of Indian Magnoliaceæ described and figured is forty-five, referred to eight genera.

Passing on to his monograph of the species of *Myristica* of British India, we find that he distinguishes sixty-eight, illustrated by sixty-nine plates. By British India, Dr. King understands political British India, including the Nicobar and Andaman Islands, and the territories of the Straits Settlements. Dr. King follows Bentham and Hooker, and others, in referring all the nutmegs to the one genus *Myristica*, and, as thus limited, it is represented in nearly all tropical countries. Ten years ago, less than a hundred species were described, but Dr. Warburg, who is at present at Kew engaged on a monograph of the order, estimates the number now in herbaria at about 200. This great augmentation is almost wholly from discoveries in the Malayan Peninsula and Archipelago, New Guinea, and Eastern Polynesia. Dr. King abstains from any attempt to trace the geographical distribution of the species, on the ground that he believes many yet remained to be discovered. But on running through his work we find that about fifty-four of his sixty-eight species are from the Malayan region, eight from the Deccan and Ceylon, and about six from the Assam and Chittagong region, only two apparently being found as far westward as Sikkim, in North India. Most of the new species are from Perak, a country exceedingly rich in endemic trees. Beyond the distribution indicated, there is one species in North Australia, and four each in Madagascar and Tropical Africa, and perhaps about forty or fifty in America, extending from South Brazil through the West Indies and Venezuela to Central America and South Mexico. The author is careful to explain that he does not regard the present effort as anything approaching finality, and anyone acquainted with the genus will understand the difficulties encountered in working from herbarium specimens alone. With one interesting exception (*Myristica canarioides*, King) the species are diœcious, and female flowers are much rarer than males; and the fruit, which affords good characters in a fresh condition, is often wanting, or not in a good state for description. But if Dr. King's work is necessarily incomplete, it supplies the very best materials for the foundation of a more exact knowledge. The figures, although possessing no great artistic merit, are faithful portraits of authentic specimens of the several species, and, combined with the very full descriptions, are sufficient to enable botanists to determine most of the species. On the other hand, the fine work in the analyses of the flowers is indistinctly reproduced in some of the plates, apparently in consequence of their having been drawn on too small a scale. The flowers, it may be added, of many species, are exceedingly small, of some not more than a twentieth of an inch in diameter. But I must draw this notice to a close with the remark that this volume is a monument to the skill and industry of Dr. King and his colleague, and a credit to the native lithographers and printers. One only marvels how the authors, with their multifarious duties, accomplish so much in a tropical climate.

W. BOTTING HEMSLEY.

MATHEMATICAL RECREATIONS AND PROBLEMS.

Mathematical Recreations and Problems of Past and Present Times. By W. W. Rouse Ball. (London: Macmillan and Co., 1892.)

THE idea of writing some such account as that before us must have been present to Mr. Ball's mind when he was collecting the material which he has so skilfully worked up into his "History of Mathematics." We think this because the extent of ground covered by these "Recreations" is commensurate with that of the "History," and many bits of ore which would not suit the earlier work find a fitting niche in this. Howsoever the case may be, we are sure that non-mathematical, as well as mathematical, readers will derive amusement, and, we venture to think, profit withal, from a perusal of it. The author forewarns possible readers that "the conclusions are of no practical use, and most of the results are not new." This is plain language, but, lest the warning should be too effectual, he adds, "At the same time I think I may assert that many of the questions—particularly those in the latter half of the book—are interesting, not a few are associated with the names of distinguished mathematicians, while hitherto several of the memoirs quoted have not been easily accessible to English readers." We have thus stated the author's *pros* and *cons*, and remark that he has gone very exhaustively over the ground, and has left us little opportunity of adding to or correcting what he has thus reproduced from his note-books.

There are two sources to which every writer on the subject of the earlier part must apply, viz. the "Problèmes plaisans et délectables," by C. G. Bachet, Sieur de Meziriac, and Ozanam's "Récréations mathématiques et physiques." These Mr. Ball carefully discusses as to editions and their respective merits.

The work before us is divided into two parts: mathematical recreations and mathematical problems and speculations. The former consists of seven chapters. In the first chapter are collected together numerous problems with numbers, watches, and cards. Some of these last are interesting to the mathematician, and have been discussed in the *Messenger of Mathematics* and the "Reprint from the *Educational Times*." The Middle Ages furnish some curious questions, and an antique problem in *decimation* is associated with the name of Josephus, but these are well-known instances. Bachet's weights problem calls for mention. It finds a place in the author's algebra; the omissions in Bachet's argument, Mr. Ball notes, have been supplied by Major MacMahon (see NATURE, vol. xlii. pp. 113, 114). Mersenne's numbers have been treated recently at some length by Mr. Ball in the *Messenger of Mathematics* (vol. xxi. pp. 34-40); in this account it is stated that $2^{61} - 1 = 2\ 305\ 843\ 009\ 213\ 693\ 951$ is the biggest known prime. Fermat claims some space (cf. NATURE, vol. xviii. pp. 104, 344). Of his so-called *last theorem* (no integral values of x, y, z, can be found to satisfy the equation $x^n + y^n = z^n$, if n is an integer greater than 2) we read:—

> "This proposition has acquired extraordinary celebrity from the fact that no general demonstration of it has been given, but there is no reason to doubt that it is true."

It is fitting that we should give Mr. Ball's grounds for this belief.

> "Fermat was a mathematician of quite the first rank who had made a special study of the theory of numbers. That subject is in itself one of peculiar interest and elegance, but its conclusions have little practical importance, and since his time it has been discussed by only a few mathematicians, while even of them not many have made it their chief study. This is the explanation of the fact that it took more than a century before some of the simpler results which Fermat had enunciated were proved, and thus it is not surprising that a proof of the theorem which he succeeded in establishing only towards the close of his life should involve great difficulties."

Proofs have been given in the cases of $n = 3, 4, 5, 7, 14$ (cf. pp. 28, 29). Many subjects of interest take up the second chapter, as "Geometrical Fallacies" (every triangle is equilateral, and the whole is equal to a part: this latter we think we have seen in an article by De Morgan); curious "Proofs by Dissection" (cf. *Messenger of Mathematics*, vol. vi. p. 87), there is a printer's error (p. 35, l. 9 up) of $\tan^{-1}\frac{1}{40}$ in place of $\tan^{-1}\frac{1}{46}$; "Colouring Maps" (only four colours necessary to colour a map of a country, divided into districts, in such a way that no two contiguous districts shall be of the same colour), the literature of this problem is brought fully up to date; an account is given of the results of Cayley's "Contour and Slope Lines," and of Clerk Maxwell's "Hills and Dales." Then follow "Statical Games of Position" ("Three in a Row" and "Tesselation," both problems connected with the name of Sylvester); "Dynamical Games of Position" ("Shunting," "Ferry-boat Problems," and numerous counter, pawn, and solitaire problems), and a glance at "Paradromic Rings."

Chapter iii. treats of "Some Mechanical Questions," as "Perpetual Motion," the "Underhand Cut on a Tennis Ball" (*Messenger of Mathematics*, vol. vii.), the "Boomerang," and the "Flight of Birds" (NATURE, 1890-91). In chapter iv. we have a miscellaneous lot, the fifteen puzzle, Chinese rings, the fifteen school-girls problem, and such card problems as Gergonne's pile problem, the mouse-trap, and many others. Chapter v. discusses "Magic Squares," and chapters vi. and vii. are devoted to "Unicursal Problems." These are Euler's problem (more fully discussed by Listing, "Topologie," and Tait), mazes, geometrical trees, the Hamiltonian game, and the knight's path on a chess-board. All these matters are treated lucidly, and with sufficient detail for the ordinary reader, and for others there is ample store of references. There is no chance of catching Mr. Ball tripping in his use of books, and his ready access to mathematical journals can hardly be surpassed, so that we have not come upon any new facts. We may mention, however, in connection with the knight's path, that there is a short article, accompanied by diagrams, on the subject in the *Leisure Hour* (December 20, 1873), by H. Meyer, of the *Hannoverische Anzeiger*.

The second part, in its opening chapter, gives at some length an account of the three classical proplems, viz. the duplication of the cube, the trisection of an angle, and the quadrature of the circle. Chapter ix., on astrology, has many curious details relating to that science, and gives a facsimile of Cardan's drawing of the horoscope of Edward VI., with an abstract of Cardan's account. On the whole matter of the chapter Mr. Ball writes:—

> "Though the practice of astrology was connected so often with impudent quackery, yet one ought not to forget that nearly every physician and man of science in mediæval Europe was an astrologer. These observers did not consider that its rules were definitely established, and they laboriously collected much of the astronomical evidence that was to crush their art. Thus, though there never was a time when astrology was not practised by knaves, there was a period of intellectual development when it was accepted honestly as a difficult but real science."

De Morgan, it may be remembered, in the "Budget" (p. 278) says:—

> "If anything ever had a fair trial, it was astrology. The idea itself is natural enough. A human being, set down on this earth, without any tradition, would probably suspect that the heavenly bodies had something to do with the guidance of affairs."

"Hyperspace," which occupies chapter x., has a full bibliography (compiled by G. B. Halsted, *American Journal of Mathematics*, vols. i. and ii.), forms the subject of one of Mr. Hinton's interesting "Scientific Romances" (cf. NATURE, vol. xxxi. p. 431), and is connected with Dr. Abbott's "Flatland" (NATURE, vol. xxxi. p. 76). Mr

Ball has made all these the text for a clear account of our present knowledge of higher space. The two last chapters rapidly survey "Time and its Measurement" and "The Constitution of Matter."

Our analysis shows how great an extent of ground is covered by the "Mathematical Recreations," and when we add that the account is fully pervaded by the attractive charm Mr. Ball knows so well how to infuse into what many persons would look upon as a dry subject, we have said all we can to commend it to our readers. The book is most carefully printed (only three or four typographical errors have met our eye, and the figures on pp. 32 and 33 the student will recognize must be drawn incorrectly).

SOILS AND MANURES.

Soils and Manures. By John M. H. Munro, D.Sc. (Lond.) (London: Cassell, 1892.)

THE preface to this book informs us that "it is written for the use of young people in schools and colleges, and those numerous other readers who take an intelligent interest in the how and why of familiar facts and operations, yet have no special training in the language and methods of science."

We must admit that Dr. Munro has succeeded in his endeavour to write a book so simple that it may be put into the hands of a beginner with confidence that he will find few difficulties unexplained, and so trustworthy that the more advanced student may find it helpful and suggestive.

We are having a flood of small agricultural books just now, consequent upon the great movement for technical education in England, but we believe that this book will reach two classes of readers which the majority of other text-books do not seem to have affected. These two classes of readers are farmers and teachers in elementary schools. Too many of these books are written with the idea of preparing students for examination, and they may serve their purpose, but are not very likely to help forward the cause of technical education in agriculture to any considerable extent.

Such education has lately been much talked about, and written about also, and men of authority and experience have even gone so far as to say that the recent attempts to promote it have mostly been failures. But if the means employed have proved inadequate or unsuitable, it does not follow that technical education in agriculture is unnecessary, or that suitable means and methods of promoting it cannot be found.

To attempt to teach the principles of agriculture to men who have no knowledge of either elementary chemistry or botany can scarcely be expected to be generally successful, nor do we hear good accounts of lectures given to farmers by men whose agricultural experience has been mainly limited to the class-room and the laboratory, and who are apt to confound agricultural chemistry with agriculture itself. Yet there are very many earnest workers on the County Councils, who have the cause of agricultural education too much at heart to let a few failures and disappointments dishearten them, and, before very long, we feel sure that they will have more reason for congratulation than at present.

Meanwhile, we can welcome this book of Dr. Munro's and wish it the success it deserves, for not only does the author avoid errors himself but he corrects a few which some other writers of elementary text-books on agriculture have fallen into. Thus, on pp. 20 and 132, he removes the impression which many beginners get (from some "cram-books" we have seen) that silica in a soluble form is very essential as a plant-food, especially to cereals. Only those who are familiar with answers to examination papers in agriculture have any idea how frequently this mistake is made.

The first part of the book, comprising five chapters, will give the reader a very good account of soils, their formation and properties; also of plant-food in the soil, how it is increased, and how rendered available for the use of plants. Included in this first part are two chapters on "Improving the Land" and "Tillage Operations," from the pen of Prof. Wrightson. These fit in well with the rest of the work.

The second part deals with the subject of manures pretty exhaustively, the author giving many illustrations from the Rothamsted experiments. The last chapter, on "Special Manures," gives instructions for valuing artificial manures from the chemical analysis, and we feel sure that the matter dealt with in this chapter will be specially useful, and do at least a little to help the farmer from being defrauded by some few unscrupulous manufacturers, still, unhappily, existent amongst us.

OUR BOOK SHELF.

Catalogue of the Specimens illustrating the Osteology of Vertebrated Animals, Recent and Extinct, contained in the Museum of the Royal College of Surgeons of England. Part III., Class Aves. By R. Bowdler Sharpe, LL.D. (London: Printed for the College and sold by Taylor and Francis, Red Lion Court, Fleet Street, 1891.)

THE first point of interest in looking into this Catalogue was to ascertain which of the innumerable schemes of bird classification had been adopted by the author; we have so many of them nowadays. Sometimes they come upon us two at a time; and to make confusion worse, aged schemes of classification, which one hoped had long ago sunk into a dishonoured grave, are sprung upon us in a fresh edition. The plan followed by Dr. Sharpe is that of Mr. Seebohm, "elaborated in his 'Birds of the Japanese Empire,'" with a few modifications. Under each order is the diagnosis; and there are a few references to the anatomical literature of the subject, which is an addition to the value of the work. These are not very full, but perhaps it is hardly necessary that they should be. A feature of this catalogue is the introduction of illustrations; there are a good many of these—48 in all. They are for the most part figures of the skull, but the syringes of a few birds and the deep plantar tendons of more are also illustrated; two figures illustrate pterylosis, and two more the under surface of the foot. The illustrations in every case are good. The Catalogue is not encumbered with huge lists of synonyms: there is only the most recently accepted name given, together with a few of the most important synonyms. The collection of bones consists of 2380 specimens, representing altogether a little over one thousand species. Some of the fossil forms are of course represented by casts only; but a number of important extinct species, notably among the Dinornithidæ, are well represented by the actual remains, in many instances the types of the species in question. We may